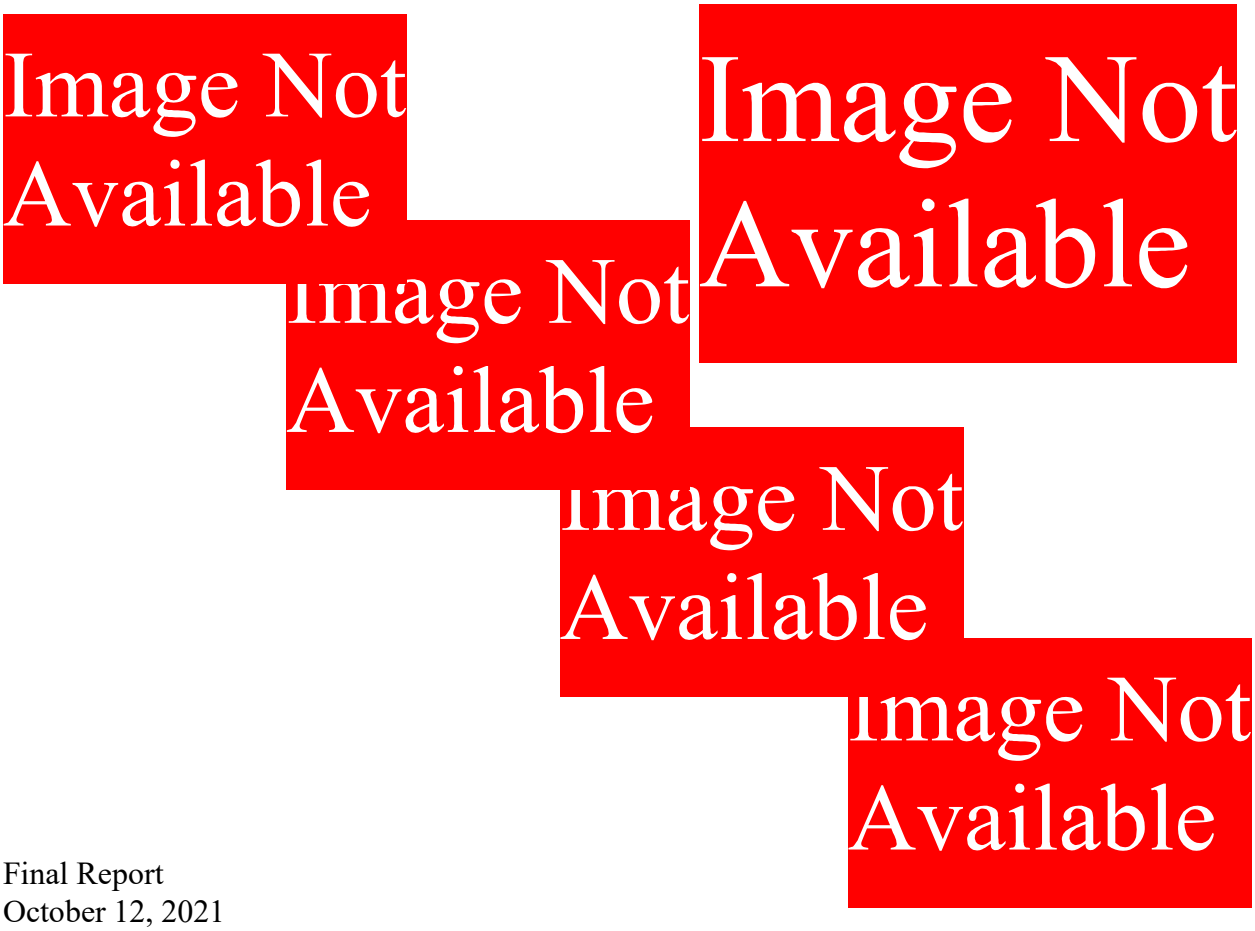
Metra Electric District

MOTIVE POWER STUDY

Evaluation of Traction Power System

Executive Summary



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List of Contents

1. INTRODUCTION 1.1
- 1.1 HISTORICAL PERSPECTIVE 1.1
- 1.2 PURPOSE OF THE STUDY 1.4
- 1.3 SCOPE OF WORK 1.5
- 1.4 METHODOLOGY 1.6
- 1.5 WORK PRESENTATION 1.7

2. PROJECT SUMMARY 2.1
- 2.1 GENERAL 2.1
- 2.2 ROLLING STOCK 2.1
- 2.3 TRACTION POWER SYSTEM 2.3
- 2.4 CATENARY SYSTEM 2.4
- 2.5 SIGNAL SYSTEM 2.5
- 2.6 COMMUNICATIONS SYSTEM 2.5
- 2.7 STORAGE AND MAINTENANCE FACILITIES 2.6
- 2.8 LIGHT AND POWER TRANSMISSION LINE 2.6
- 2.9 REAL ESTATE REQUIREMENTS 2.7
- 2.10 COST ESTIMATES 2.7

1. INTRODUCTION

1.1 HISTORICAL PERSPECTIVE

1.1.1 Railroad Beginning

The rail lines now operated by the Metra Electric District were originally built by the Illinois Central Railroad (IC). The IC had begun operating southward from Hyde Park (53rd Street) on May 22, 1852. The first IC suburban service trains began running on July 21, 1856 from Randolph Street terminal to Hyde Park. The ridership grew at a spectacular rate, doubling between 1900 and 1920, by which time there were 294 daily train runs. To cope with the high number of passengers, the IC developed a highly efficient operation, introduced high level station platforms, purchased the Sullivan type cars with 10 doors per side, and began considering electrification.

1.1.2 Choice of Electrification System

Various systems of electrification were carefully studied before a choice was made. The choice was between direct current (DC) systems at moderate electrification voltage and alternating current (AC) systems at high electrification voltage. The DC systems would require more elaborate equipment on the wayside, but very simple equipment on the trains. The AC systems, on the other hand, required heavier and more expensive equipment on the trains, but minimal equipment along the wayside.

AC electrification system thus would be a good choice for a long distance electrification involving hundreds of miles of line and relatively few locomotive-hauled or multiple unit (MU) trains. DC system, on the other hand, seemed to be the best choice for the IC system electrification, which would involve only a relatively short line, but hundreds of electric MU cars. Since the traffic on IC's Mainline beyond the suburban territory was too light to offer any economic justification for long distance type of electrification, the choice thus was made to use a 1,500 V DC system. This voltage, about double that used by the elevated system and the streetcars, greatly reduced line losses and allowed substations to be spaced along the route at wider intervals.

1.1.3 Beginning of Electric Service

On July 21, 1926, the first electric suburban train ran from Randolph Street to 67th Street. Formal inauguration of electric operation through to Matteson took place on August 27, 1926. Soon electric trains covered all suburban service on the Mainline to Matteson, and the South Chicago and Blue

Island Branches. By 1929, 542 daily electric suburban trains were handling 121,000 daily passengers and the IC electrification was a resounding success.

1.1.4 Equipment Innovations

While the electrification was initially applied only to the suburban service, it was intended that it would eventually take over all freight and long-distance passenger operation within the city to eliminate smoke and noise of steam operation. The electrification system equipment was selected and designed with great care. For example, the IC requested the two major manufacturers of electrical equipment, General Electric and Westinghouse, to offer traction motors which were completely interchangeable. After extensive testing both motors were found to be satisfactory, and half of the order was placed with each supplier. The control equipment for all cars was supplied by General Electric.

Most of the substations had motor-generator sets to convert the AC power from the utility to the DC power required by the trains. A few of the substations were equipped with mercury arc rectifiers which were just beginning to be available. With no moving parts, the rectifiers required much less supervision and maintenance. A major innovation was that the substations would be owned and operated by Commonwealth Edison, rather than by the railroad. The utility was more accustomed to substation operation than the railroad and realized savings in equipment maintenance through economies of scale.

1.1.5 Recent Equipment Enhancements

In the 1970's the value of commuter service to the community was recognized and the South Suburban Mass Transit District, a predecessor of Metra, was created and provided assistance to the IC, by then merged into the Illinois Central Gulf (ICG) railroad.

New cars were purchased to replace the original electric cars. Following the lead of most of the other railroads operating suburban service in Chicago, the new cars were of the bi-level gallery type, providing the maximum number of seats per car. Because the IC operation, especially at the congested loop stations and the terminal, required passengers to be able to board and alight very quickly, the cars were designed with more doors than those of other railroads.

At the same time, automated fare collection was introduced on the ICG Suburban service as a major innovation. This was the first large-scale application of a system using magnetically-encoded tickets and fare gates which read the tickets electronically. Also, the original rotary converters and mercury-arc rectifiers in the traction power substations were replaced with solid-state rectifiers.

1.1.6 Metra Electric District System Today

In 1982 the operation of the Electric District has been taken over by Metra. Since the suburban passenger operation has been separated from the long-distance passenger and freight operations, the transition has been easier than in cases where commuter and freight operations had to be integrated on jointly-owned tracks.

Immediately upon beginning operation, Metra embarked on a modernization program of its facilities. This modernization included rehabilitation of the existing equipment as well as installation of new facilities.

The Metra Electric District rolling stock consists of 165 Highliner cars built between 1971 and 1978. All cars were overhauled between 1989-1996. The cars have been re-cambered, corroded steel has been replaced, and the car systems were reconditioned with some upgrades. However, the cars will soon reach the end of their useful life.

In the traction power substations, PCB-filled traction power transformers were replaced with dry-type or oil-filled transformers and the original AC and DC circuit breakers were replaced with modern switchgear. The DC feeder cables, the 4.16 kV lighting and power cables, and the 2.3 kV signal power supply cables were also replaced. Additional systems were introduced, such as the supervisory control and data acquisition system (SCADA), the DC circuit breaker fail protection, and the transfer trip protection.

The catenary system has undergone major rehabilitation. Contact wire wear is continuously monitored and significant sections of contact wire have been replaced. Although old, the present system is in a remarkably sound condition. The tensions in the conductors are being monitored and re-tensioning is performed as required. De-wirements are rare and a program of pole foundation repair is ongoing.

Much of the signal system today needs to be updated. The existing Mainline track circuits with US&S Model 15 relays are still very reliable but their maintenance and repair are costly, as the relays have not been available since the 1970's. The major interlockings, Randolph and Kensington, are in satisfactory condition being equipped with phase-selective coded track circuits. In the near future, the 67th Street Interlocking Tower is going to be replaced and split into three interlockings (65th, 67th and 69th) with the same type of track circuits. The Mainline south of Kensington is in the Centralized Traffic Control (CTC) territory and is controlled from the Central Control Facility (CCF).

The South Chicago Subdistrict signal system has had little or no updates since the 1950's. Along with maintenance of the many AC track circuits, maintenance of insulated joints is required. Because of the 36 (soon to be 38) at-grade crossings, much of the crossing protection has hold down circuits, station dwell time, speed measuring, and interlocking type relays for stick circuits.

The Blue Island Subdistrict is in marginally better condition than South Chicago Subdistrict. The single track systems includes one spring switch passing track.

The communication system for the Electric District is owned and operated by Metra. The system consists of telephone, radio, SCADA, station public address (PA), and station closed circuit televison (CCTV) subsystems. There are two control centers serving the system. The CCF is the principal communications control center for the entire railroad operated by Metra. The second facility is the Passenger Assistance Link (PAL) Center. PAL's main function is to provide a manned communications link, both audio and visual, to Metra passenger stations on the Electric District. The communication equipment located at passenger stations, power substations, and other rail right-of-

way (ROW) locations are connected to the two control centers by fiberoptic, coaxial, and copper cables. These communications connections are supplemented by telephone voice and data circuits leased from Ameritech.

The Metra Electric District has six maintenance and storage facilities, Randolph Street/North Terminal, Weldon/18th Street Yard, Kensington Yard (KYD), Blue Island Yard, Matteson/Richton Park Yard, and University Park Yard/South Terminal. The facilities serve for routine inspection, light repair, major repair and overhaul, exterior car wash, interior car cleaning, wheel truing, and car storage.

The Light and Power (L&P) Transmission System supplies AC electrical power to passenger stations, Maintenance-of-Way (MOW) buildings, street/subway lighting, interlocking towers, bridges, signal system equipment, snow-melter systems, and other locations along Metra Electric District routes. The system consists of two distinct transmission subsystems, L&P Power four-wire, three-phase distribution system rated at 4.16 kV/60 Hertz, and Signal Power two-wire, ungrounded, single-phase distribution system rated at 2.3 kV/60 Hertz. Each of the subsystems receives power from the traction power substations via wire atop the overhead catenary system supports. Duplicate power lines are installed on the most critical portions of the Mainline.

1.2 PURPOSE OF THE STUDY

Since inception of the original electrification system, the electrical equipment operated safely and reliably. Today, some of the original equipment is still in service after more than 70 years of continuous operation. Due to the equipment age, some of the subsystems and components may be at the end of their useful life and need to be upgraded or replaced.

Furthermore, the existing cars that replaced the original electric cars are 20-30 years old. The cars have already undergone one rebuilt cycle, and now the car bodies are deteriorating. The cars still use the obsolete and inefficient cam-controlled propulsion system. With significant investments for the system modernization already committed, and a new large investment to replace the 165 cars potentially ahead, Metra wishes to evaluate the next step in the electric system development and assess how to continue serving the commuter passengers in the new century.

Taking into account the recent and projected passenger volume increases, the primary purpose of this study is to determine the answers to the following fundamental questions:

- What are the rolling stock replacements options? Should the existing rolling stock be replaced with the same type of equipment or should new technology, such as AC propulsion, be introduced?
- Would it be advantageous to use locomotive-hauled trains with trailer cars?
- Should the existing 1,500 V DC traction power supply and distribution systems be retained and augmented with additional power supply facilities to supply the projected level of service, or should the system be converted to a new electrification system operating either at 12.5 kV AC or 25 kV AC electrification voltage?

If the existing system is retained, it is necessary to answer the following:

- What modifications to the existing traction power system are required to supply year 2020 traction loads?
- What new equipment is required and what are the equipment ratings?
- What is the realistic, least service disrupting, and most cost-effective approach for implementing the system augmentation?
- What additional system components need to be renovated and upgraded?
- What is the cost of the system augmentation and upgrade?

In the event that either the 12.5 kV AC or the 25 kV AC system is more advantageous to Metra, the following questions need to be answered:

- What should the configuration of the new system be?
- What impact would the voltage increase and use of commercial frequency have on vehicle modifications, overhead catenary system clearances, signaling system compatibility, and change of other miscellaneous subsystems?
- What would be the environmental impact of the system conversion?
- What would be the operational impacts of voltage and frequency changes on Metra and the Northern Indiana Commuter District (NICTD)?
- What is the realistic, least time-consuming, and most cost-effective approach for implementing the system conversion?
- How would the system conversion be accomplished with minimum disturbance to train operation during construction?
- How would the new system construction be coordinated with vehicle conversion?
- What other system improvements are necessary due to obsolete equipment and change in voltage and frequency?
- What are the impacts of construction of new transmission lines for power supply to new substations?
- What are the major risks to successful project implementation?
- What is the cost of the system conversion?

Additionally, an evaluation into the possibility of dual-power locomotive (DPL) use is required. In the event that Metra extends its service in the future, *e. g.*, to the proposed South Suburban Airport (SSA) planed to be located near Peotone, Ill, by the State of Illinois Department of Transportation (IDOT), the DPL-hauled trains would be an option to extension of the electrification system.

1.3 SCOPE OF WORK

The Metra Electric District consists of the Mainline rail route between the downtown Chicago Randolph Street Station and the University Park Terminal. There are also two spur rail lines branching off of this Mainline, the South Chicago Branch and the Blue Island Branch. The study evaluates the systems used on the Metra Electric District commuter lines as shown in Table 1-1.

Table 1-1 - Metra Electric District Commuter Lines

Line Name	Extent of the Study	Approximate Route Length (miles)	Number of Passenger Stations	Maximum Operating Speed (mph)
System Mainline	Randolph Street to University Park	31.4	34	65
South Chicago Branch	Mainline to South Chicago 93rd Street	4.7	8	30
Blue Island Branch	Mainline to Blue Island	4.4	7	30
Total System Under Study		**40.5**	**49**	

1.4 METHODOLOGY

The work on the project is divided into three tasks, and each task is, in turn, divided into subtasks as shown in Table 1-2.

Table 1-2 - Metra Electric District Study Tasks and Subtasks

Metra Study Tasks	Study Subtasks
Task 1: Data Collection, Site Inspection, Interviews, and Inventory of Existing System	1.1 Data Collection and Review 1.2 System Inspection and Evaluation 1.3 Staff Interviews 1.4 Inventory of Existing System
Task 2: Evaluation of Existing System	2.1 Existing Operation Criteria 2.2 Rolling Stock 2.3 Traction Power System 2.4 Catenary System 2.5 Signal System 2.6 Communications System 2.7 Storage and Maintenance Facilities 2.8 Light and Power Transmission Line 2.9 Real Estate Requirements 2.10 Environmental Impact 2.11 Cost Estimates 2.12 Recommendation and Implementation
Task 3: Project Definition/Concept Planning	3.1 Design Criteria 3.2 Rolling Stock 3.3 Traction Power System 3.4 Catenary System 3.5 Signal System 3.6 Communications System 3.7 Storage and Maintenance Facilities 3.8 Light and Power Transmission Line 3.9 Real Estate Requirements 3.10 Environmental Impact 3.11 Cost Estimates 3.12 Conclusions and Recommendations

The work performed in Task 1 is an indispensable effort which forms the cornerstone of the Motive Power Study. The purpose of the task is to prepare an overview and inventory of the Metra Electric District system elements, vehicles, and facilities.

Based on the Task 1, analysis of the existing Metra systems, vehicles, and facilities is performed in the Task 2 with regard to future system operation costs. A comprehensive power system study is performed for the current passenger density, and systems and facilities needing augmentation are identified. As some of the system components are more than 70 years old and might be close to the end of their useful life, consideration is given to future maintenance costs. The objective of this task is to evaluate and determine which parts of the Metra Electric District system can continue to be used, which parts need upgrading, and which parts need replacement.

In Task 3, alternative systems that could either supplement or replace the existing 1,500 V DC electrification system are evaluated taking into consideration passenger density projected for the year 2020. Any proposed electrification system needs to have sufficient capacity to supply adequate power to the trains and meet future system operating requirements. The objective of this task is to develop conceptual designs for at least three alternative systems, each capable of supporting Metra's operation projected to the year 2020. Impacts, benefits and costs of each system are required to be developed, and the most advantageous system for the Metra Electric District needs to be identified.

1.5 WORK PRESENTATION

Consistently with the three tasks outlined above, the Metra Motive Study report is presented in the following volumes:

- Volume 1 - Data Collection, Site Inspection, Interviews, and Inventory of Existing System
- Volume 2 - Evaluation of Existing System
- Volume 3 - Project Definition and Concept Planning

In order for each volume to be a stand-alone document, this introductory Section 1.0 is presented in each volume. For a comprehensive project overview, however, the reader should have an access to all three volumes.

For an quick review of the project objectives and determinations, this Executive Summary combines the introductory section with the conclusions of the three Volumes.

2. PROJECT SUMMARY

2.1 GENERAL

The Metra Electric District system components were reviewed and evaluated. The components included:

- Rolling Stock
- Traction Power System
- Catenary System
- Signal System
- Communications System
- Storage and Maintenance Facilities
- Light and Power Transmission Line

During the course of the study numerous site visits were made and real estate requirements for new traction power substations and additional storage and maintenance facilities were identified. Also, many discussions were held with Metra personnel who maintain and operate these systems. Based on the site observations, the input from Metra personnel, and the study evaluations, the conclusions discussed below can be made.

2.2 ROLLING STOCK

Three bi-level cars were visually examined from the shop floor and from the pits underneath the cars. Additionally, the roof and upper level of one car was inspected from a mechanical lift platform. In general, the cars appeared in well maintained condition. Wheels showed slight flange wear, but no obvious flat spots or imperfections. The major detraction was bulging of internal corrosion along the side sill. Some spots were open, that is, the paint over the corrosion had flaked away. Some corrosion was also evident along the roof to side junction and some isolated spots on the sidewalls. Truck frames, under frames and end frames all seemed free of serious corrosion. No other problems, such as cracking or physical damage, were observed.

The cars were in various degrees of rehabilitation, and some of the original equipment systems which proved troublesome have been replaced with more reliable equipment. Some of the subsystems, particularly the motor-alternator for auxiliary power and the propulsion cam controller, while serviceable, are obsolescent by current standards.

Following the visit to the Metra KYD shop, a report prepared by Virginkar/STV[1] was reviewed and additional discussions were held with Metra staff. The report and the follow-up discussions revealed that many of the Highliner cars had far more extensive corrosion than was evident in the cars examined. Additionally, this investigation made clear that rebuilding or rehabilitation of the present fleet is not practical because some cars have structural weakness that cannot be permanently corrected.

Based on these evaluations, it was concluded that the entire fleet of rolling stock should be replaced. In order to determine which type of the rolling stock is the most advantageous for Metra, operations characteristics, capital costs, as well as operations and maintenance costs were evaluated for the following rolling stock replacement options:

- Bi-Level EMUs
- Electric Locomotives with Push-Pull Operation Using Bi-Level Cars
- Dual Power Locomotives with Push-Pull Operation Using Bi-Level Cars

Life Cycle cost estimates for each of the three rolling stock options under considerations are derived in Table 2-1 as a sum of the total capital cost and the present worth of operations and maintenance costs.

Table 2-1 -Rolling Stock Life Cycle Cost Estimate

Rolling Stock Option	Cost	Cost Estimate (millions of dollars)	Total Life Cycle Cost (millions of dollars)
Bi-Level EMUs	Capital	659	1,152
	Operations and Maintenance	493	
Electric Locomotive with Push-Pull Bi-Level Cars	Capital	666	1,133
	Operations and Maintenance	467	
Dual Power Locomotive with Push-Pull Bi-Level Cars	Capital	722	1,420
	Operations and Maintenance	698	

The total capital costs were increased by so-called add-on amounts for contractor's mobilization and demobilization, consultant's design and engineering support, construction management, agency engineering support, agency construction support, compliance with specification's general conditions, environmental assessment effort, laboratory testing allowance, field testing and commissioning, spare parts, special tools and equipment, system documentation, training, and construction contingency.

The O&M costs were estimated over 30 year period using annual inflation rate of 4%. The present worth of the O&M costs was calculated assuming annual interest rate of 8%.

[1] **The Economic Life Analysis Study Report for Metra Highliner Cars**, Virginkar & Associates in association with STV, April 1999.

The table shows that although the capital cost of EMUs is the lowest, the Electric Locomotive with Push-Pull Bi-Level Cars option is the most cost effective overall. However, despite the cost difference, the bi-level EMUs are preferable to the electric locomotive-hauled trains and the dual power locomotive-hauled trains for the following reasons:

- The EMUs have a higher acceleration rate than the locomotive-hauled trains. This characteristic is of critical importance to achieving the scheduled trip times.
- The EMUs have the flexibility to quickly change consist sizes. This feature is very important in the busy and congested Randolph Street passenger station.
- The required fleet of EMUs can be purchased for a lower price than either the electric locomotive-hauled trains or the dual power locomotive-hauled trains.
- The new fleet of EMUs can be stored in the existing storage yards. The locomotive-hauled trains would require additional storage yard space and, and in the case of the dual power locomotive-hauled trains, a refueling facility would be needed.

It is recommended that Metra replaces the existing and aging EMU fleet with modern EMUs. The new rolling stock should be of modern design and be equipped with state-of-the-art materials and subsystems. The new EMUs are recommended to include stainless-steel body and AC propulsion system with IGBT inverters and induction motors.

2.3 TRACTION POWER SYSTEM

The traction power system upgrades already performed included improvement of all components of the system. New 15 kV distribution switchgear has replaced the obsolete circuit breakers. The old PCB filled main step-down transformers have been replaced with new dry-type or oil-filled transformers. New power distribution switchgear has replaced older and obsolete circuit breakers. The old disconnect switches were replaced. Recently, a new DC circuit breaker transfer trip equipment has been installed. The aging power feeder distribution cables leaving the substations and supplying power to the railway right-of-way overhead power connection points, have been replaced with new non-lead covered cables.

The traction power system load-flow simulations show that when the rolling stock operates with the present schedule, the EMU field weakening disabled, and at the maximum train speed limit of 65 mph, the system operates on the margin, but the voltages along the system are satisfactory. When the rolling stock operates with the field weakening enabled and at maximum train speed limit of 65 mph or 75 mph, the system voltages drop below acceptable values. In order to achieve this higher level of performance, the existing system needs to be augmented. Prior to Metra initiating this level of train performance, it is recommended to install four new package type substations at an approximate cost of $7 million.

Three traction power supply and distribution system options were evaluated for implementation on the Metra Electric District for the projected service level increase between now and year 2020:

- Augmentation of the existing 1,500 V DC system

- Conversion to a new 12.5 kV AC system
- Conversion to a new 25 kV AC system

All three systems under consideration were found to be technically suitable to supply the existing and future electrical loads. As already mentioned, the existing 1,500 V DC system is already operating at capacity and, in order to support the increased power requirements, would have to be augmented by provision of new substations and tie stations.

Augmentation of the existing DC electrification system has the following technical and cost advantages in comparison with replacement with alternative AC systems:

- The DC system is considered more flexible than the AC systems. With relatively close substation and tie station spacings, track outages following catenary system fault or during catenary maintenance are much shorter in length, and therefore, have significantly lower disruptive effects on the system operation.
- The existing system has been upgraded over the years. Today the system is in a very good condition and can be expected to serve for another 20 years.
- The catenary system re-insulation and provision of adequate clearances for the high voltage AC system would be expensive and would have a significant effect on the passenger service during construction.
- The AC system substations are of considerable size and would cause a significant environmental impact. This could result in lengthy legal and regulatory proceedings.
- Implementation of the DC system to AC system conversion would be accompanied with significant track outages. Therefore, community acceptance and any resulting benefits would be very low.
- The life cycle cost analysis of each of the three systems indicates that the cost of the existing system augmentation is significantly lower than provision of a new AC system.

Considering the above factors, it is recommended that the existing 1,500 V DC electrification system is augmented with additional substations and tie station, rather than replaced by AC electrification system. The new facilities used for the system augmentation are recommended to be factory-assembled package-type units that can be installed with practically no adverse effects on the system operations.

2.4 CATENARY SYSTEM

The catenary system and the car pantographs are performing satisfactorily, and with no indications of any imminent or short term problems. Regular inspections and follow-up maintenance have avoided wire tear downs. However, some of the catenary foundations are in need of repair. Also, some of the catenary structural steel, such as the base plates, need replacement. Other structural steel members require cleaning and painting to prevent further deterioration. Metra's current catenary foundation replacement program can be expanded to include repair of the catenary structural steel as needed as well as painting and rust proofing of the structures. A training manual, similar to the

concrete foundation replacement manual, should be produced for the repair and painting of the structural steel.

Evaluation of the catenary system indicates that it is desirable to change the existing fixed-termination system to an auto-tensioned system. Auto-tensioning improves train current collection due to improved pantograph dynamic tracking and avoids future need for re-tensioning.

Since auto-tensioned catenary system is the universally preferred choice over fixed-termination system, it is recommended that the Metra catenary system is upgraded from the existing fixed-termination system to the auto-tensioned system. For Metra to maintain a train service during the period of the catenary system upgrade, it would be necessary for the electric trains to continue to operate while one track, at a time, is taken out of service for the upgrade work

2.5 SIGNAL SYSTEM

The signal system track circuits are being replaced with new microprocessor-based vital track circuits. The mainline signal system is in good condition, but the South Chicago Sub District signal system is aging and needs to be replaced. The Blue Island Branch is in marginally better condition than the South Chicago Line because some of the equipment has been recently updated.

The existing Mainline signal system is set for trains to run at a maximum speed of 65 mph. However, current signal work upgrade program, including signal repaying, interlocking upgrade, and control from the CCF, would enable the maximum operating speed to be raised to 79 mph in the future.

NICTD has already taken delivery of 10 new cars with equipped Toshiba DC to AC IGBT-type inverter propulsion systems and has retrofitted six of its existing cars with the same propulsion system. NICTD has successfully performed extensive field testing of the cars over various types of signal apparatus, some of which is also used by Metra. The tests demonstrated that the NICTD and Metra signal systems are compatible with the new inverter drives, and consequently, similar type of technology can be used on the future rolling stock purchased by Metra.

2.6 COMMUNICATIONS SYSTEM

Metra is continuing to upgrade all SCADA systems and the SCADA communications will eventually move over from the currently leased Ameritech lines to the Metra-owned fiber optic cables. When the addition of the Microwave back-up link is completed, the Metra communication system will be a completely self-healing network in the case of any fiber cable outage. Metra's communication system is continuing to improve and its reliance upon new technologies provides Metra with the state-of-the-art communications system.

The new traction power substations and tie stations are recommended to include SCADA equipment comparable to, and compatible with, the existing SCADA system. The new equipment will include

cable connections, security CCTV system, SCADA cabinets with REUS, fire alarm panels, and door intrusion equipment.

The SCADA equipment at the OFF is recommended to incorporate all necessary provisions for the new traction power substations and tie stations. This will include new fiber optic circuit connections, new backup circuits, and re-programming of existing CCF SCADA system equipment to include monitoring and control of the new facilities. Further, future work should include software graphic display upgrades as well as re-designing and rebuilding of existing SCADA Route Map Board to accommodate the new substations and tie stations.

2.7 STORAGE AND MAINTENANCE FACILITIES

Metra has comprehensive storage and maintenance facilities to its disposal. The facilities enable Metra to store their fleet of cars and perform all maintenance functions including interior car cleaning, exterior car wash, routine inspection, light repair, major repair and complete overhaul, as well as wheel truing. Although several instances of inadequate lighting, access, and parking were noted, these are not serious problems. Some of these problems are already being addressed by consultants and designers.

The new Electric District fleet size for year 2020 is projected to include 185 EMUs, an increase of 20 cars over the current fleet size. Following an analysis of the available storage, places were found for all 185 future EMU cars.

2.8 LIGHT AND POWER TRANSMISSION LINE

The existing overhead power distribution system cables and associated supports are being replaced with a spacer cable type arrangement. To date, the Blue Island Branch has been completed and work continues on the Mainline and the South Chicago Branch. The existing power distribution monitoring and control systems have been replaced to ensure continuing operation of the system. The supervisory control and data acquisition systems (SCADA), initially installed during the 1960's and 1970's, are being upgraded as a part of the ongoing rehabilitation program.

Investigation into existing light and power transmission line loads revealed that the circuits are relatively lightly loaded. Future signal circuit installation plans, new passenger stations loads, and maintenance facility details indicate that the transmission system has an adequate spare capacity and can accommodate an increased level of loading in the future. Therefore, no line augmentation, beyond the current line rehabilitation program is recommended at this stage. When Metra is able to determine L&P power loadings more accurately via their upgraded SCADA System, a comprehensive analysis of the transmission system should be conducted.

2.9 REAL ESTATE REQUIREMENTS

The new package-type 1,500 V DC system substations and tie stations are of relatively small size. The substations typically measure 16 feet x 46 feet and the tie stations are approximately 16 feet x 18 feet. The facilities cause a low environmental impact and can be often located on, or adjacent to, the railroad right-of-way.

2.10 COST ESTIMATES

Preliminary cost estimates appropriate for this level of study were developed for each electrification system option. All costs were estimated in year 2001 U.S. dollars.

2.10.1 System Capital Cost

The system capital cost estimate consisted of the following:

- Rolling Stock Cost Estimate
  - Existing 1,500 V DC System Augmentation
  - 12.5 kV AC System Conversion
  - 25 kV AC System Conversion
- Traction Power Supply System Cost Estimate
  - Existing 1,500 V DC System Augmentation
  - 12.5 kV AC System Conversion
  - 25 kV AC System Conversion
- Traction Power Distribution System Cost Estimate
- Signal System Cost Estimate
- Communications System Cost Estimate
- Storage and Maintenance Facilities Cost Estimate
- Diesel Operation Cost Estimate

2.10.2 System Operations and Maintenance Cost

The system operations and maintenance cost estimate included the following:

- Operations Cost Estimate
  - Point of Supply and Power Demand Charge Cost Estimate
  - Energy Cost Estimate
- Maintenance Cost Estimate
- Present Worth of Operations and Maintenance Cost Estimate calculated over 30 year period assuming annual inflation rate of 4% and annual interest rate of 8%.

2.10.3 Cost Summary

The life cycle cost was calculated for each of the three systems options under consideration as a sum of the system capital cost and the present worth of the Operations and Maintenance cost. The cost estimates revealed, as presented in Table 2-2, that the existing 1,500 VDC system augmentation is significantly more cost effective than implementation of either of the AC system alternatives.

Table 2-2 -Traction Power System Life Cycle Cost Estimates

Traction Power System Option	Cost	Cost Estimate (millions of dollars)	Total Cost (millions of dollars)
Existing 1,500 V DC System Augmentation	Capital	745	823
	Operations and Maintenance	78	
New 12.5 kV AC System	Capital	857	931
	Operations and Maintenance	74	
New 25 kV AC System	Capital	914	987
	Operations and Maintenance	73	

The Metra Electric District traction electrification system is in very good condition and its augmentation is recommended over the AC system alternatives due to the system cost advantage, higher flexibility, lower environmental impact, and minimum disruption to the traveling public.